Top Dilepton Cross-Section Report

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for Dilepton Group

Changes to Event Selection

- Extend jets to $|\eta| < 2.5$
  - Winter analysis used $|\eta| < 2.0$
- Cutting on corrected instead of raw quantities
  - Use Jet Corrections 1,2,3,5
  - Count jets with corrected $E_T > 15$ GeV
    - Winter analysis used raw $E_T > 10$ GeV
  - Use these jets to correct MET and calculate H_T
- As was done in Run I, loose central leptons not required to be isolated
  - Does not apply to CMIOs
- Trilepton category added
- CMX muons no longer vetoed if have CMU/BMU stubs

New Z Veto

- Not so new:
  - CDF 3387 (H. Frisch)
- Exploit the fact that MET from top is real while MET in Z+jets results from jet under-measurement
  - Expect that higher jet ET → higher jet fluctuation → larger MET.
- Events with MET > 60 GeV ->jet lost in a crack (η = 0 or 1.1)-> use Δϕ(MET, jet) to reject those events

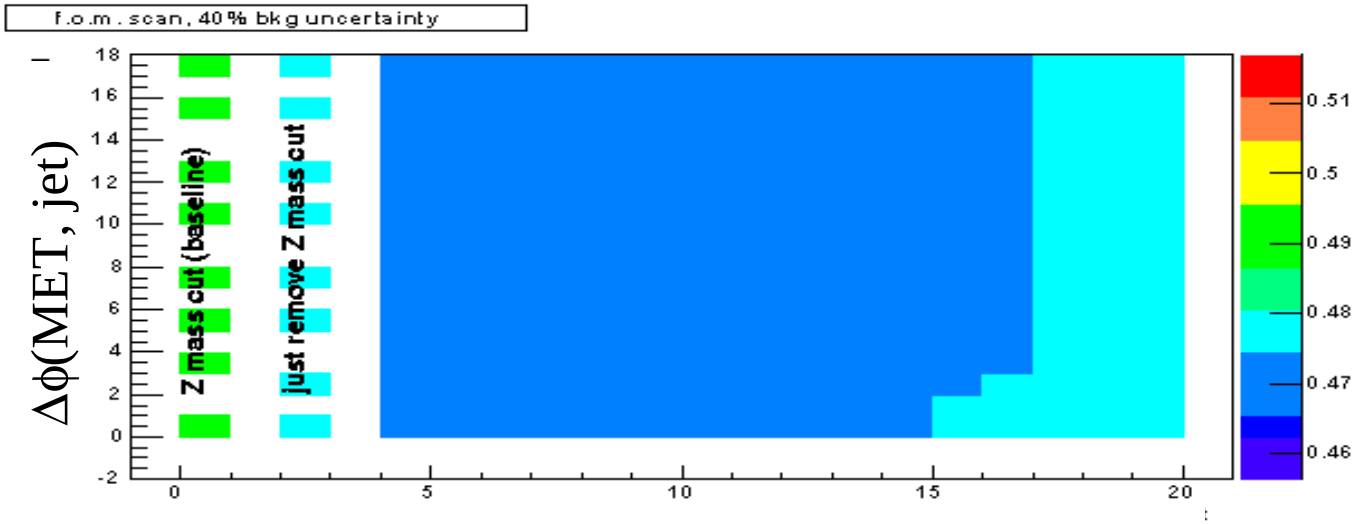
$$jetsig = \frac{MET}{\sqrt{\sum_{|\Delta f(met,jet)<90|} (\vec{E}_T jet \cdot \frac{\vec{MET}}{MET})}}$$

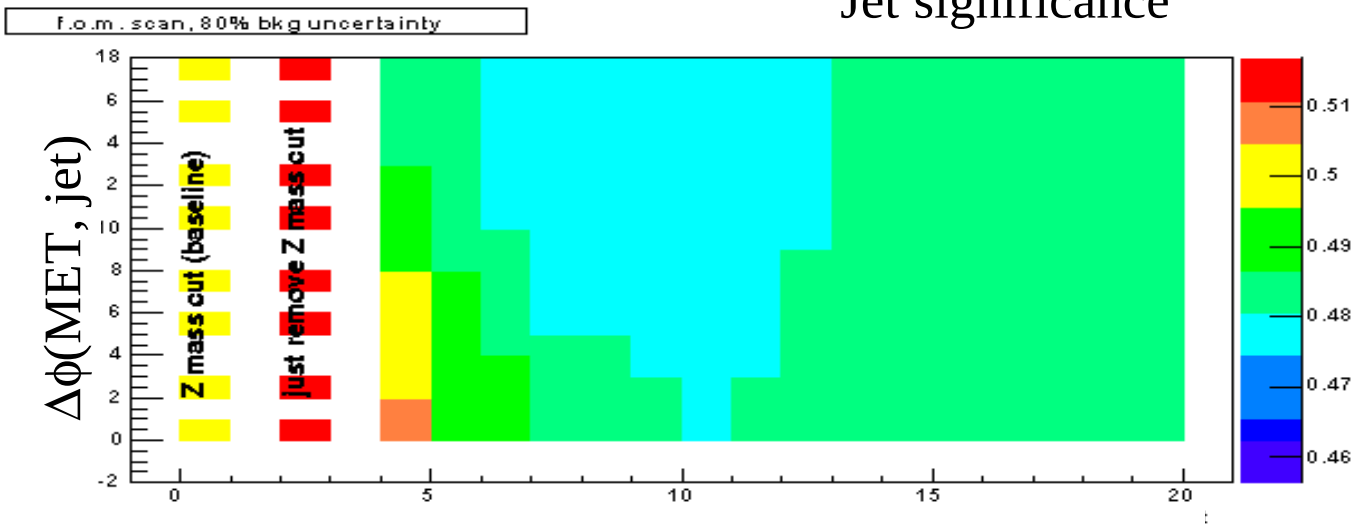
MET/σ_{MET}

How to optimize this cut ?

f.o.m = uncertainty on the xsec

jetsig > 8.0
Δϕ(MET,jet) >10





Central Electron ID

- Central electrons selected according to ETF baseline cuts for E_T < 100
  - Essentially unchanged from winter
    - E_T > 20 GeV
    - HadEm < 0.055 + 0.00045*E
    - Lshr < 0.2
    - Iso4 <0.1
    - P_T > 10 GeV
    - E/P < 2, if E_T <=100 GeV
    - P_T > 50 GeV, if E_T >100 GeV
    - -3.0 cm < Δx*Q_trk < 1.5cm
    - $|\Delta z|$ < 3 cm
    - CES χ^2 Strips < 10
    - Track $|Z_0|$ < 60 cm
    - Fiducial = 1 (Ces |X|<21 cm, 9< Ces |Z|<230 cm)
  - All good central electrons are TIGHT ≡ CEM

Plug Electron ID

- Plug electrons selected according to ETF baseline cuts, E_T < 100 GeV except as noted below in RED
  - LOOSE ≡ PEM
    - E_T > 20 GeV
    - Had/Em <0.05
    - Iso4 < 0.1
    - PEM3x3FitTower !=0
    - PEM3x3FitChi2 < 10
    - PES 5by9 u and v > 0.65
    - Fiducial based on PES 1.2 < |η| < 2.5
  - TIGHT ≡ PHX
    - In addition to the above, must also have phoenix track
      - # Si Hits ≥ 3
      - Track |Z0| < 60cm
      - DeltaR_Track/PES < 3cm
        - » Redudant since phoenix algorithm seeds track with PES
  - Note: PEM and PHX categories are exclusive
  - Note: PHX e's must be in the plug fiducial region

Muon ID

- Muons are selected as in the winter with the addition of non-fiducial CMIOs passing the additional cut in RED
  - Pt > 20 GeV
  - HadEnergy < max(6.,6.+0.0280*(P-100))) GeV
  - EmEnergy < max(2.,2.+0.0115*(P-100))) GeV
  - |Z0| < 60
  - If CMUP |CmuDx|< 3 and |CmpDx| < 5
  - If CMU |CmuDx|< 3
  - If CMP |CmpDx|< 5
  - If CMX |CmxDx|< 6
  - If CMIO, HadEnergy + EmEnergy >0.1 GeV
  - CMIO must be nonfiducial to muon chambers (MuonFiducialTool)
  - TrkAxSeg > 3
  - TrkStSeg > 3

  } Track Quality Cuts

  - If TrkSiHits > 0, |D0|< 0.02
  - Otherwise |D0|< 0.2

Event Selection

- Require two leptons passing ID cuts
  - At least one of which is TIGHT
- Require both leptons to be isolated
  - Relaxed for 2nd central lepton (except CMIO)
- If leptons are same-species with $76 < M_{ll} < 106$ GeV
  - Require "Jet Significance" > 8.0
  - $\Delta\phi$(MET, closest j) > 10°
- Corrected MET > 25 GeV
- $\Delta\phi$(closest l or j,MET) > 20° if MET < 50 GeV ("L" cut)
- Two jets with $|\eta| < 2.5$ with corrected $E_T > 15$ GeV
  - Using jet corrections levels 1,2,3,5
- Require corrected $H_T > 200$ GeV
- Require leptons to be opposite signed
  - Does not apply to PEM which do not have tracks

Dilepton Categories

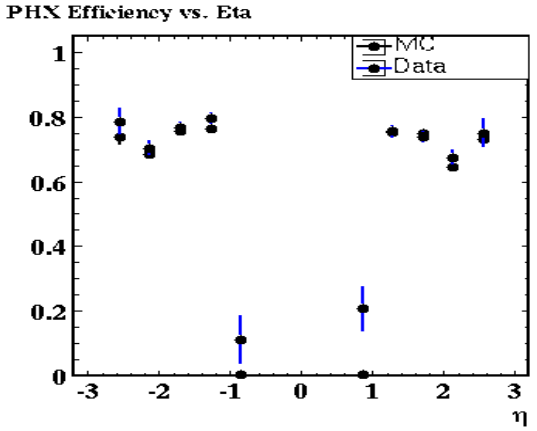
- Events are required to have two leptons
  - At least one of which is TIGHT ISOLATED lepton
- Trigger lepton is required to be TIGHT
- Permuting TIGHT with LOOSE
  - **26** dilepton categories
    - ee: 5 categories
    - eμ: 9 categories
    - μμ: 12 categories
  - **1** trilepton category

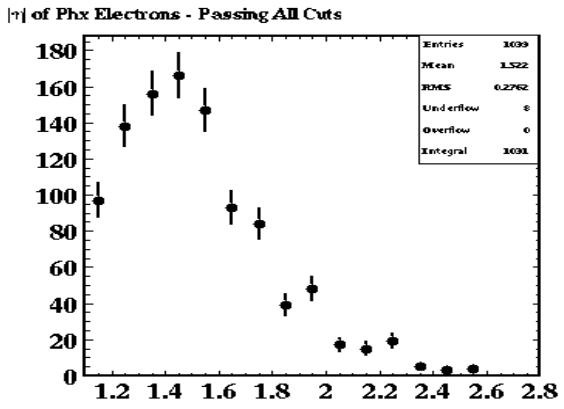
TIGHT	LOOSE
CEM	PEM
CMUP	CMU
CMX	CMP
PHX	CMIO

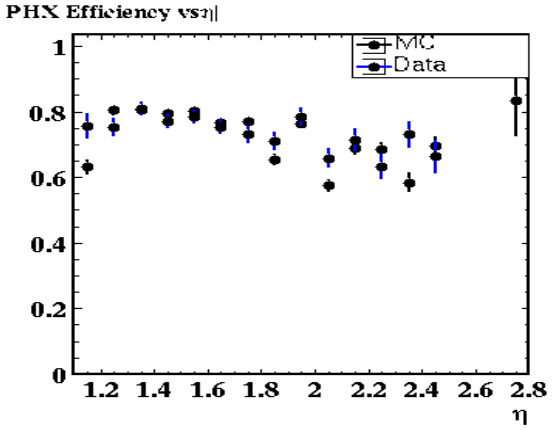
σ(W) & σ(Z) as cross-checks for PHX electrons

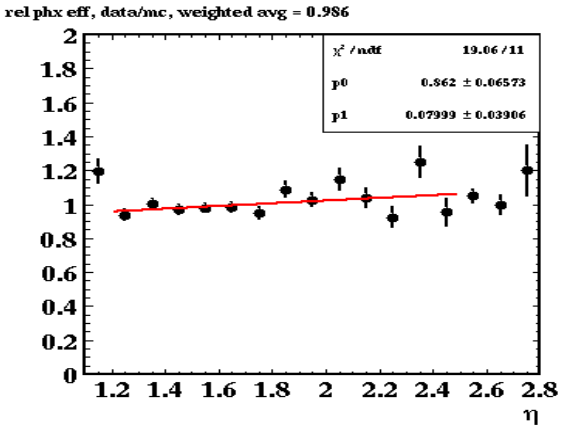
- PHX Efficiency SF w/ 4.11.1 = 0.986

Used plug data:
Z->ee(CP) ?



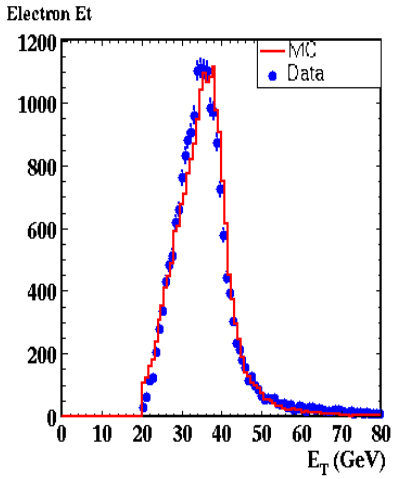


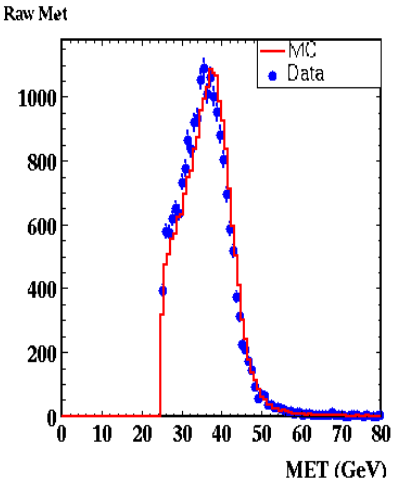


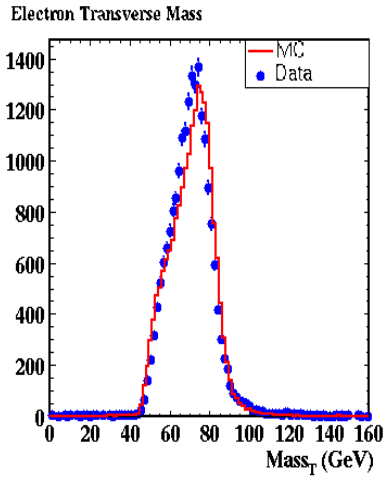


PHX W Cross-Section

- Look at bpel08
  - Si goodruns only
- Require one PHX electron passing dilepton analysis cuts
- Require MET > 25 GeV
- # W candidates
  - 20,215 events





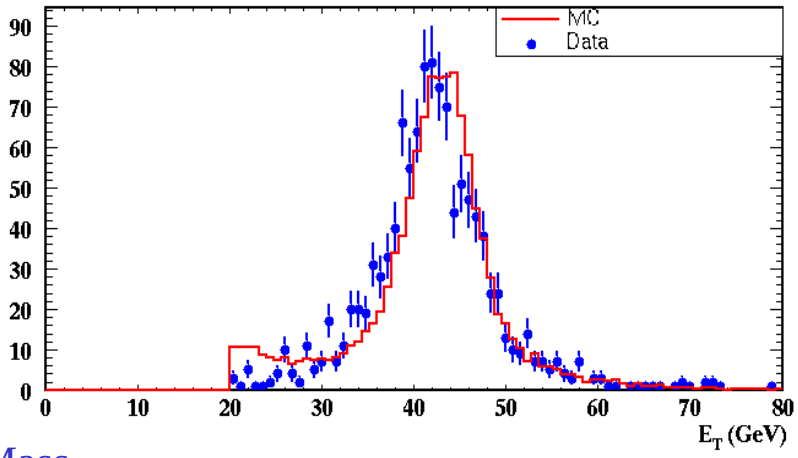


s x B(W® en) = 2.4 nb

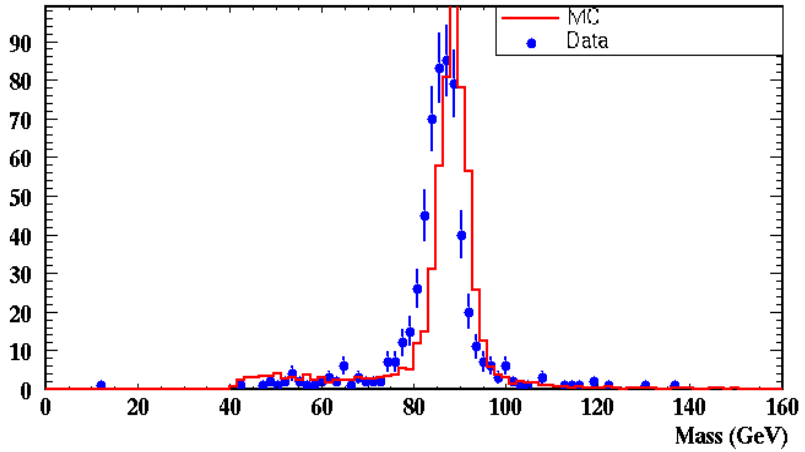
PHX Z Cross-Section

- Look at bpel08
  - Si goodruns only
- Require two PHX electrons passing dilepton analysis cuts
- # Z candidates
  - 578 events

Electron E_T



Di-Electron Mass



s x B(Z® ee) = 259 pb

ttbar Acceptance (from ttopli MC)

	Dilepton Cut							NJets				
Category	Geom-Pt	ID	iso	conv,cosm	Z veto	$\not\!\!E_T$	$\Delta\phi$ ($\not\!\!E_T$, ℓ/j)	0j	1j	2j	$H_T > 200$	OS
TCE-TCE	16964	956	932	882	823	747	677	3	95	579	560	543
TCE-PHX	4117	547	519	505	474	419	383	2	53	328	311	290
TCE-PEM	3160	157	127	122	113	99	92	0	14	78	76	76
PHX-PHX	356	73	65	64	63	55	49	0	7	42	39	30
PHX-PEM	412	33	25	24	24	18	15	0	1	14	14	14
cc	25009	1766	1668	1597	1497	1338	1216	5	170	1041	1000	953
CMUP-CMUP	591	352	345	345	315	280	252	1	20	231	224	213
CMUP-CMU	228	135	120	120	110	102	89	1	8	80	77	74
CMUP-CMP	334	221	198	198	185	165	153	0	20	133	125	120
CMUP-CMX	475	310	307	307	283	252	229	1	27	201	196	190
CMUP-CMIO	1991	265	195	195	186	157	136	0	14	122	116	116
CMX-CMX	116	75	75	75	67	56	48	0	6	42	41	40
CMX-CMU	83	60	51	51	45	37	33	0	3	30	28	25
CMX-CMP	119	86	77	77	73	67	59	0	4	55	52	49
CMX-CMIO	863	114	83	83	79	77	68	0	11	57	57	57
$\mu\mu$	4800	1618	1451	1451	1343	1193	1067	3	113	951	916	884

ttbar Acceptance II

	Dilepton Cut							N.Jets				
Category	Geom-Pt	ID	iso	conv+cosm	Z vtx	$\not\!\!E_T$	$\Delta\phi$ $(\not\!\!E_T, \ell/j)$	0j	1j	2j	$H_T > 200$	OS
TCE-CMUP	6687	1237	1217	1185	1185	1041	934	3	101	830	801	774
TCE-CMU	1308	241	215	213	213	191	171	2	22	147	139	135
TCE-CMP	1774	353	315	308	308	266	241	2	28	211	206	198
TCE-CMX	2743	522	518	504	504	441	396	3	49	344	328	321
TCE-CMIO	15399	423	322	317	317	279	252	0	38	214	205	205
PHX-CMUP	809	323	308	304	304	260	243	1	28	214	203	179
PHX-CMU	139	41	40	40	40	34	32	0	2	30	29	27
PHX-CMP	251	95	91	90	90	81	74	0	7	67	66	61
PHX-CMX	357	124	116	115	115	104	98	0	11	87	81	76
PHX-CMIO	1914	91	70	67	67	60	53	0	11	42	39	36
PEM-CMUP	579	93	73	72	72	57	55	2	5	48	44	44
PEM-CMX	264	37	31	31	31	27	21	0	2	19	17	17
$e\mu$	32224	3580	3316	3246	3316	2841	2570	13	304	2253	2158	2073
II	17333	57	51	47	0	44	42	0	14	28	28	0
III	3281	2	1	1	0	1	1	0	0	1	1	0
IIII	0	0	0	0	0	0	0	0	0	0	0	0
Total 382000	62033	6964	6435	6294	6156	5372	4853	21	587	4245	4074	3910

Sample composition

	Dilepton category (after Geom/Pt Cuts)		
ttbar dilepton source WW→	ee	$\mu\mu$	e μ
ee	83.53 ±1.20	0 ± 0	0.10 ± 0.07
$\mu\mu$	0 ± 0	83.14 ±1.26	0 ± 0
$\tau\tau$	0.42 ± 0.21	0.23 ± 0.16	0.48 ± 0.15
eτ	11.23 ±1.02	0.11 ± 0.11	6.03 ± 0.52
eμ	0 ± 0	0 ±0	83.26 ± 0.82
$\mu\tau$	0 ±0	13.35 ± 1.14	6.37 ± 0.54
ejj	4.8 ± 0.69	0 ± 0	1.88 ± 0.30
μjj	0 ±0	2.6 ± 0.54	1.74 ± 0.29
τjj	0 ±0	0.57 ± 0.25	0.14 ± 0.08
jjjj	0 ±0	0 ± 0	0 ± 0

Table 1: Relative acceptancies to the ttbar dilepton signal.

Acceptance Summary

Total Acceptance: Herwig: 3910/382000 = 1.02 %
Pythia : 3813/398037 = 0.96 %

- Acceptance :
  - By region:
    - CC = 78 %
    - CP = 20 %
    - PP = 2 %
  - By lepton:
    - ee = 23%
    - eμ = 53%
    - μμ = 24%
- Increase from winter = 200%
  - By change (approximately):
    - Adding plug + corrected cuts: 0.52% → 0.73%
    - Drop 2nd leg isolation, new cuts: 0.73% → 0.89%
    - Remove Z mass cut: 0.89% → 0.93%
    - Add CMIOs: 0.93 → 1.02%

Herwig:
- does not have FSR photon radiation coming off of leptons
- uses the theoretical BR(W→l)

Go for Pythia ?

DY(ee, μμ) Background Estimate

- Outside the mass window (76, 106) GeV, we use the technique from Winter (CDF 6322)-> extrapolate #Z's inside window N_Z^{2j} to outside region + MC AlpGen to get effs for H_T
- Inside the mass window:
  - from data -> N_Z^{2j} inside Z window
  - from DY+2p AlpGen+Herwig get $\varepsilon_{ZVeto \cdot MET\ \Delta\phi.\ HT\ OS}$
  - In ~120 pb^{-1}:

Channel	Outside Z Win	Inside Z Win
ee	0.16 ± 0.10	0.56 ± 0.07
$\mu\mu$	0.10 ± 0.09	0.35 ± 0.05
Sub-Total	0.26 ± 0.14	0.91 ± 0.09
TOTAL	1.17 ± 0.17	

WW/WZ Background Estimate

- WW- Follow the Winter experience (CDF 6290)

  →use Pythia wtop0f (562 fb^{-1}):

  - in 100 pb^{-1}: 0.306+- 0.112 events
- Keep on eye on the studies performed in WW Group to get a better 2 jet fraction efficiency
- WZ: use wtop0q (an order of magnitude smaller than WZ):

  - In 100 pb^{-1} we expect: 0.054+- 0.022 events ? cross-section was wrong !!

$Z \rightarrow \tau\tau$

- In Winter (CDF 6320) we showed that Pythia, Herwig (sick !) and Madgraph estimates agree at the 20 % level->systematic uncertainty
- Use Pythia ztop2t + correct the 2-jet fraction using the data (Winter factor):
  - In 100 pb^{-1}: 0.266+- 0.114 events

Fake Background Estimate

- Method I: Using the Winter technique (CDF 6260), with small tunings
- Preliminary numbers will be available for tomorrow

Method II

- Fakes from W+3 jets where one of the jets fakes a lepton, so can get fakes by:
  - Measuring lepton fake rate per “jet” from JET20. JET50, JET70
    - “Jet ” definition includes tracks not clustered in a jet to account for MIPs faking muons
  - Applying to W + 3 “jet” events in inclusive lepton sample
- Note: the numerator is a subset of the denominator

Jet probability = Num/Den		
	Electrons	Muons
Numerator	TCE,PEM or PHX	CMUP,CMP, CMU, CMX, CMIO
Denominator	Corrected Jets $\eta > 2.5$, $E_T > 15$ GeV	Corrected Jets $\eta > 2.5$, $E_T > 15$ GeV + Tracks $P_T > 10$ GeV

Method II

- Use inclusive leptons datasets to count

  #W(e_i)>+ 3 jets (1 lepton + 3 jets+ MET+ L cut),

  where i = CEM, PHX or PEM

  #W(μ_j)>+ 3 jets or tracks (1 lepton + 3 jets or tracks+ MET+ L cut),

  where j = CMUP,CMU, CMP, CMX, CMIO
- Apply the fake probability * 2 j eff * H_T eff

Method II: Results

- Fake probability (averaged over jet20, 50, 70 samples)

CEM:	5.7 e-7	NICEM:	7.8 e-5
PEM:	3.6 e-4	PHX:	6.2 e-5
CMUP:	3.9 e-7	CMU:	1.2 e-7
CMP:	2.6 e-7	CMX:	1.3 e-7
NICMUP:	1.6 e-5	NICMU:	9.8 e-6
NICMP:	1.6 e-5	NICMX:	8.8 e-6
CMIO:	1.3 e-7		

#W+3 jets evts from central dataset: 451

#W+3 jets or MI tracks from central dataset: 1216

#W+3 jets evts from plug dataset: 176

#W+3 jets or MI tracks from plug dataset: 337

CC fakes: 0.13 evts CP fakes: 0.30 evts PP fakes: 0.12 evts

Total fakes expected: 0.56 evts (after all cuts).

Cross-checks: W+heavy flavor

- Use the numerous W+HF AlpGen+Herwig samples to estimate this background per 100 pb^{-1}. W+HF contribution to dilepton is part of the fake estimate; this is just a check
- In 100 pb^{-1} : < 0.05 events

atop16 W(μν)bb0p	0.0022 evts	atop13 W(eν)cc0p	0.0064 evts
atop10 W(eν)bb0p(OLD)	0.0066 evts	atop19 W(μν)cc0p	0.0038 evts
atop40 W(eν)bb0p(NEW)	0.0035 evts	atop0w W(eν)c0p	0.007 evts
atop41 W(eν)bb1p	0.0046 evts	atop3w W(μν)c0p	< 0.012 evts (0 evts pass all cuts)
atop1w W(eν)c1p	0.0043 evts	atop4w W(μν)c1p	0.026 evts

Dilepton Good Run List

Lumi with minimal requirements: ~125 /pb

Require good CMX: ~109 /pb

Require good Si, no CMX req.: ~108 /pb

Require good Si and CMX: ~96 /pb

The question is, do we use all four, or just the last two?

- I don't want to throw away 20 pb^{-1}.
- I'm leaning toward the "maximize lumi" point of view. Andy is pretty advanced in writing a script to combine all the numbers.

Background Summary:

- Use 125 pb^{-1} (the different luminosities for different categories folding will be ready for the preblessing)

First look at the data

- Search for candidates in the inclusive ele, muon, plug dataset ->almost all the data was skimmed
- 12 candidates:
  - ee: 2 events
  - eμ: 6 events
  - μμ: 4 events

{ 1 CEM-CEM
1 CEM-PEM }

{ 2 CEM-CMX
1 CEM-CMIO
1 CME-CMU }

{ 2 CMUP-CMP
1 CMUP-CMX
1 CMX-CMX }

- Any more candidates ?

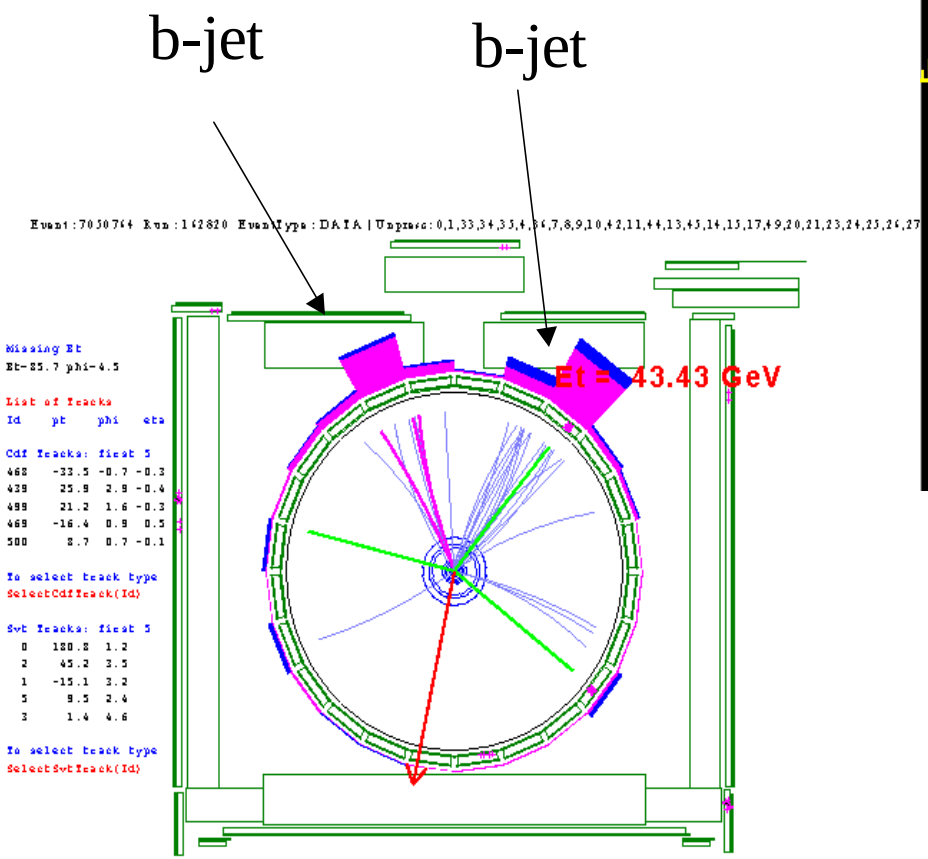
For the dilepton fans

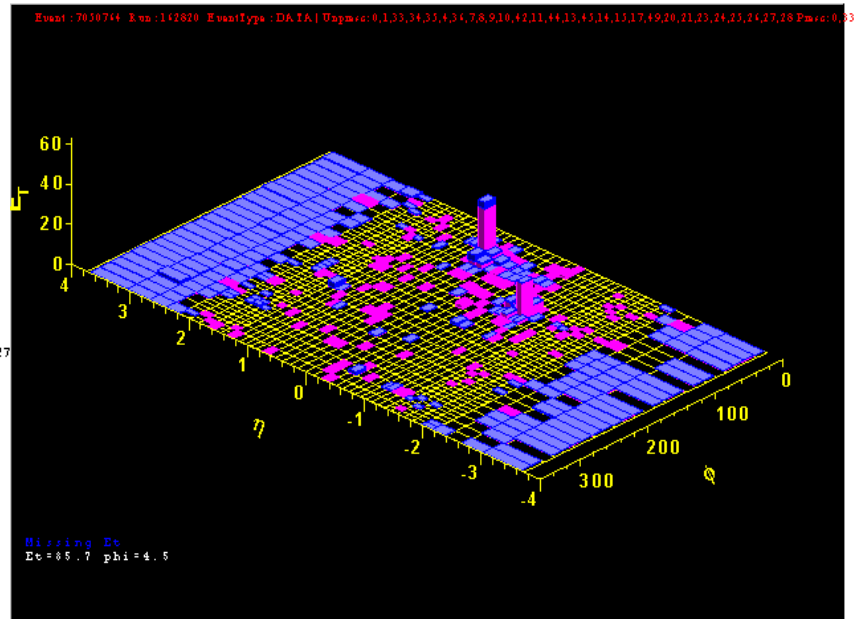
- CEM-CME : run/ev: ,153374/2276742 , #jets: 3
- CEM-PEM : run/ev: , 154208/966753 , #jets: 3
- CEM-CMUP:run/ev: , 151978/507773, #jets: 2
- CEM-CMP : run/ev: , 143257/760520, #jets : 4
- CEM-CMX : run/ev: , 155114/478702 , #jets: 3
- CEM-CMX : run/ev: , 156484/3099305, #jets: 3
- CEM-CMU : run/ev: , 162178/4932257, #jets: 2
- CEM-CMIO : run/ev: , 161633/963604 , #jets: 3
- CMUP-CMP: run/ev: , 153447/2643751, #jets: 3
- CMUP-CMP: run/ev: , 162820/7050764, #jets: 2
- CMUP-CMX: run/ev: , 154654/7344016, #jets: 2
- CMX-CMX : run/ev: , 153325/599511, #jets: 3

The b-tagging information

- 6 tagged candidates (not checks if the run is in the Silicon Good Run List yet), one is double tagged (CMUP-CMX)
- CEM-CEM:
- CEM-PEM:
- CEM-CMUP:
- CEM-CMX:
- CMUP-CMP:
- CMUP-CMX:

Double-tagged event





Summary and Plans

- Acceptance has been doubled relative to the winter conference results, while S/B ~ 7
- Finish the list of candidates (plug data not skimmed yet->became available Monday)
- Cross-checks the fake background between different methods
- Documentation close to be posted
- Estimate the systematic uncertanties
- Plan to pre-bless next week